REMARKS

The above amendments to the above-captioned application along with the following remarks are being submitted as a full and complete response to the Office Action dated January 24, 2008. In view of the above amendments and the following remarks, the Examiner is respectfully requested to give due reconsideration to this application, to indicate the allowability of the claims, and to pass this case to issue.

Status of the Claims

Claims 22-26, 50-52 and 55-58 are under consideration in this application. Claims 40-47 are being cancelled without prejudice or disclaimer. Claims 20 and 50-52 are being amended, as set forth in the above marked-up presentation of the claim amendments, in order to correct formal errors and/or to more particularly define and distinctly claim applicant's invention. New claims 55-58 are being added.

All the amendments to the claims are directed to the elected Group I (a method of forming a step-terrace structure on a SiC surface) and supported by the specification. Applicants hereby submit that no new matter or new issue is being introduced into the application through the submission of this response.

Prior Art Rejections

Claims 22-23, 25-26, 40-42, 44, 47 and 50-51 were rejected under 35 U.S.C. §103 (a) as being unpatentable over Powell et al. (US 6,165,874) in view of Semond et al. (WO 01/95380; US 2003/0136333), and claims 24, 43 and 45 were rejected further in view of Forbes et al. (US 2004/0164341). Claims 46 and 52 were also rejected further in view of Kitabatake (US 2001/0015170). These rejections have been carefully considered, but are most respectfully traversed.

The crystal growing method of the present invention (for example, the embodiment depicted in Figs. 1-3), as now recited in claim 22, comprises the steps of: forming a step-terrace structure that is flat at an atomic level (p. 2, last paragraph) on a SiC surface 2 and then removing an oxide film, which is naturally formed thereon and covers the step-terrace structure, from the surface; after the forming and then removing step, performing at least one cycle of a process including irradiating Si or Ga atomic beam 5 on the surface 3 ("*In the ultrahigh vacuum state, an irradiation of a Ga atomic beam 5 was started at time t1...*" p. 8, 3rd paragraph; "*Preferably, the Ga irradiation is interrupted during heating (as indicated by*

the solid line)." P. 8, last paragraph) and then heating the irradiated surface thereby separating said Ga or Si from the irridiated surface and removing oxygen on the surface ("*the separation of Ga from the surface*" p. 9, lines 4-5; "*the amount of oxygen on the surface after the Ga irradiation and heating process was below the measuring limit of the measuring apparatus.*" P. 9, 2nd paragraph); and after the performing step, growing a Group-III nitride 7 on the surface without said Ga or Si left in-between.

As recited in claim 51, the Group-III nitride contains Al, and the step of growing a Group-III nitride is conducted under high vacuum and comprises the steps of: feeding Ga or In as a surface controlling element for controlling the mode of crystal growth to be layer-by-layer of the Group-III nitride on said SiC surface; and then feeding a Group III element and nitrogen, followed by the termination of the feeding of said surface controlling element (p. 15, lines 1-4). As recited in claim 55, the surface controlling element is either fed in a form of gas (p. 16, 2nd paragraph) or irradiated on the surface in a form of an atomic beam (p. 15, lines 1-2).

The invention of claim 50 is directed to the method of claim 22 and additionally that the oxide film which is naturally formed on said surface in an atmosphere of reduced oxygen partial pressure, and growing a Group-III nitride on the surface by feeding a Group III element and feeding nitrogen after the Group III element has been fed.

Applicants respectfully contend that none of the cited references or their combinations teach or suggest such steps of "performing at least one cycle of a process including irradiating Si or Ga atomic beam 5 on the surface 3 and then heating the irritated surface thereby separating said Ga or Si from the irradiated surface and removing oxygen on the surface" and "growing a Group-III nitride 7 on the surface without said Ga or Si left in-between" as the present invention. The present invention uses Ga as a surface controlling element (claim 51) which is not present in the final structure (including only the SiC substrate 1 and the AlN layer 7; Fig. 1D).

As admitted by the Examiner (p. 3, 3rd paragraph of the outstanding Office Action), Powell does not teach removing an oxide film, performing at least one cycle of a process of irradiation of Si or Ga, heating, and then growing a Group-III nitride. Semond was relied upon by the Examiner to provide the relevant teachings. However, Semond merely applies fast thermal annealing on the substrate to remove a native oxide layer ([0089]), but not to "perform at least one cycle of a process including irradiating Si or Ga atomic beam 5 on the surface 3 and then heating the irratiated surface thereby separating said Ga or Si from the

irradiated surface and removing oxygen on the surface" or "growing a Group-III nitride 7 on the surface without said Ga or Si left in-between" as the present invention.

In contrast, Semond only uses MBE process (molecular beam epitaxy) ([0093]) ***after*** growing the AlN buffer layer 22 ([0094]), rather than ***before*** growing the AlN layer 7 on the surface as the present invention. In addition, Semond uses the MBE process to grow/leave GaN layers 23 ([0094]) in the final structure (e.g., Fig. 2). On the other hand, the present invention uses Ga as a surface controlling element (claim 51) which is not present in the final structure (including only the SiC substrate 1 and the AlN layer 7; Fig. 1D). It is well established that a rejection based on a cited reference having contradictory principles or principles that teach away from the invention is improper.

Moreover, Semond's AlN layer 22 is merely a buffer layer for growing the GaN layers 23. Semond simply is not aware of or concerns with any need to remove the slightly remained oxygen from Si or SiC surface prior to growing the AlN buffer layer 22 as the present invention. Obviously, the Ga/Si irradiation process of the present invention is not part of GaN growth as in Semond.

Irradiating Si or Ga atomic beam and then heating away said Ga or Si is to form a very clean surface on SiC without reside oxygen. The heating process is to evaporate deposited Ga or Si along with oxygen from the SiC surface. At least one (preferably three) cycles of the irradiation and heating (desorption) process is effective (p. 8, last paragraph). It is well known that the native oxide (SiO2) can be eliminated by hydrofluoric acid (e.g., Fig. 1B); however, only the inventors discovered that the slightly remained oxygen exerts a bad influence on the growth of nitride on a step-terraced SiC surface. Semond only mentioned that thermal heating up to 950°C is effective to eliminate native oxide on the Si surface, but did not realize that such a process is not sufficient to remove all native oxide removal from the SiC surface for very high-quality growth of nitride on SiC. The inventors found that in addition to hydrofluoric acid etching (most oxygen atoms are removed by this process), it is essential to deposit Ga or Si and then eliminate the deposited Ga or Si by heating, preferably 3 runs or more to remove the slightly remained oxygen from SiC surface ("*through the Ga irradiation and the subsequent heating process, it became possible to virtually completely remove the oxygen on the surface that had not been completely removed by the hydrofluoric acid process or that had been adsorbed via the atmosphere while the substrate was being mounted on the MBE apparatus following the hydrofluoric acid process*" p. 9, 2nd paragraph).

In addition, the inventors found that the effects of this oxygen eliminating process is especially effective for very high-quality group III nitride growth in the case of forming a step-terrace structure on the SiC surface. The above mentioned effect was further disclosed in the concurrently filed IDS reference: Express Letter of Japanese Journal of Appl. Phys. Vol. 42 (2003) pp. L445-L447 as attached (See Fig 4 of this application which is the Fig. 2 of the IDS ref. for RHEED oscillation which was clearly observed in the case of (1) a SiC surface is controlled to include a step-and-terrace structure, (2) the SiC surface is treated by hydorofluoric acid, and (3) Ga-deposition and re-evaporation process (marked as (c) at the bottom of Fig. 2). The IDS reference was released by the same inventors after the filing of this application. The worst case is marked as (a) in Fig. 2 which is processed only with HF treatment and heating (but without Ga deposition/re-evaporation). The data clearly show that the claimed invention exhibits the unexpected results of high quality growth of nitride on a SiC substrate, which can not achieve by the combination of Powell and Semond.

The other cited references fail to compensate for the deficiencies of Powell and Semond as discussed above.

Applicants contend that neither the cited references, nor their combinations teach or suggest each and every feature of the present invention as recited in independent claims 22 and 50. As such, the present invention as now claimed is distinguishable and thereby allowable over the rejections raised in the Office Action. The withdrawal of the outstanding prior art rejections is in order, and is thus respectfully solicited.

Conclusion

In view of all the above, clear and distinct differences as discussed exist between the present invention as now claimed and the prior art reference upon which the rejections in the Office Action rely, Applicants respectfully contend that the prior art references cannot anticipate the present invention or render the present invention obvious. Rather, the present invention as a whole is distinguishable, and thereby allowable over the prior art.

Favorable reconsideration of this application is respectfully solicited. Should there be any outstanding issues requiring discussion that would further the prosecution and allowance of the above-captioned application, the Examiner is invited to contact the Applicants' undersigned representative at the address and telephone number indicated below.

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